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10. Abstract (optional - 250 word limit)

Indonesia's Automated Frequency Management System (AFMS), under the Department of Communications Directorate General of Posts and Telecommunications (POSTEL), supports the assignment of reliable interference-free frequency assignments to Indonesia's telecommunications community and infrastructure. It plays a pivotal role in Indonesia's ability to react quickly and efficiently to domestic and international demands for telecommunications radio frequency spectrum decisions. The technical, operational and administrative database is the core of the automated process. The successful operation of the AFMS relies entirely on complete and accurate technical and operational data residing within the automated system. A high degree of integrity and reliability must be resident and maintained in this inventory of computerized information. Measured against the guidelines adopted by the International Telecommunications Union (ITU), of which Indonesia is a member, and other international spectrum management Administrations utilizing similar facilities, the POSTEL database is significantly inaccurate and incomplete and is therefore seriously flawed as a modern automated spectrum management tool. The corrective action described in this report will require a dedicated but modest allocation of human and minimal financial resources, for a specific period of time, to form a Project Team to review, identify, highlight and correct all technical and operational data elements withing the existing database deemed to be compromised or unusable. Additionally, an audit process should be introduced in order to verify accuracy of future data entered into the system.

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A Review of Indonesia's Automated Frequency Management System (AFMS) Database

By Richard Nassar

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EXECUTIVE SUMMARY

Indonesia's Automated Frequency Management System (AFMS), which is under the Department of Communications Directorate General of Posts and Telecommunications (POSTEL), supports the assignment of reliable interference-free frequency assignments to Indonesia's telecommunications community and infrastructure. It thus plays a pivotal role in Indonesia's ability to react quickly and efficiently to domestic and international demands for telecommunications radio frequency spectrum decisions in a rapidly expanding technological environment. The technical, operational and administrative database is the core of the automated process. Inasmuch as the successful operation of the AFMS relies entirely on complete and accurate technical and operational data residing within the automated system, it is of fundamental importance that a high degree of integrity and reliability be resident and maintained in this inventory of computerized information.

A technical and operational audit of the AFMS database has been carried out and the results analyzed in the light of what is deemed essential for the system to operate to its capability and efficiently support the activities of POSTEL and the Ministry.

- Measured against the guidelines adopted by *the International Telecommunication Union (ITU)* of which Indonesia is a member, and other international spectrum management Administrations utilizing similar facilities, the POSTEL database is significantly inaccurate and incomplete. As a modern automated spectrum management tool, it is therefore seriously flawed.

There are several steps which can be taken to correct and raise the level of the database to a condition where it can do the job it is designed to do. This would additionally have the effect of making the daily activities of POSTEL more efficient and reliable to its national clientele and international obligations. The corrective action described in this report will require a dedicated but modest allocation of human and minimal financial resources for a specific period of time. The allocation of the resources together with a planned integrated approach over a conservative period of time is expected to result in a reliable inventory of essential data which, once achieved, must be maintained on an on-going basis. The time span required to complete this project will depend almost entirely on the investment of resources POSTEL is prepared to make.

To achieve this goal, it is proposed that an investment of a limited number of persons be allocated to the formation of **a Project Team to review, identify, highlight and correct all technical and operational data elements within the existing database deemed to be compromised or unusable.** Additionally, an audit process should be introduced in order to verify accuracy of future data entered into the system.

INTRODUCTION

Frequency Management is usually defined as the administrative and technical procedures necessary to ensure the operation of radio stations of different radio communication services at any time without causing or receiving harmful interference.

The radio frequency spectrum is a natural resource. It is a resource which has, over time, acquired increasing strategic importance to the world generally, and to nations specifically. In developed nations it is a key and fundamental component of those nation's communications systems and infrastructure. With today's rapidly expanding technology, the value of the spectrum holds the same promise for all nations alike. Compared to other natural resources, the radio frequency spectrum possesses some unique characteristics. Although it has finite limits of capacity, it is physically intangible and indestructible. More importantly, it only has utility when it is being used. Also, the radio frequency spectrum is available everywhere at the same time and, hence does not respect political boundaries. It is therefore incumbent upon nations and administrations to manage this resource, through judicious use of planning and technology, as efficiently as possible, both within their own borders and internationally.

International co-ordination, co-operation and regulation have been a feature of the management of radio frequency spectrum from the early stages of its history. This has taken place under the auspices of the International Telecommunication Union (ITU). Only recently has efficient national spectrum management come to be recognized as a fundamental prerequisite to a nation's development of a sound communications infrastructure. In other words, good spectrum management fosters the structure and orderly development of a country's national and international telecommunications services and facilities.

Normally, Governments are mandated with the responsibility to manage the radio frequency spectrum for its citizens and Indonesia is no exception. Indonesia's Department of Communications, through its Directorate General of Posts and Telecommunication (POSTEL) has responsibility for spectrum management in Indonesia.

The discipline of spectrum management has advanced rapidly in recent years and one of the most significant advancements has been in the area of automation. The ITU has encouraged automation in spectrum management as a means of developing more accurate and technologically based decision-making. This has taken place in an increasingly congested radio frequency spectrum environment worldwide but fortunately, the advantages of automated spectrum management are available to all nations equally. However, as in any other application of computer techniques, satisfactory and successful results depend entirely on the validity and accuracy of information being introduced into the system. This report deals with the application and reliability of the core information being used in Indonesia's Automated Frequency Management System (AFMS).

BACKGROUND

In the early 1990's, POSTEL moved to an automated frequency management mode of operation designated as the Automated Frequency Management System. (AFMS). The system, based on the Government of Canada's well-established and successful Spectrum Management System (SMS), was marketed by a private company and ultimately

customized to meet Indonesia's spectrum management needs in conformance with the manner in which POSTEL managed the radio frequency spectrum.

Essential components of any automated system are the data being manipulated by that system. This "database" of essential data elements represents the heart of the system and the various calculations performed by the system rely entirely on valid and accurate data in order for the various computerized algorithms to perform correctly.

While a modern day automated spectrum management can perform many functions including those of an administrative, fee charging and reporting nature, the most involved feature *is that of performing complex frequency and mathematical manipulation calculations between various existing and newly proposed frequency assignments to ensure interference-free operation by all users.* This is commonly known as the "***technical analysis***" component. Virtually every kind of radio station frequency calculation can be performed, including those affecting broadcasting (radio and TV), cellular operations, police, fire and national defense radio usage and private radio frequency systems such as taxi dispatch, delivery and other uses of radio.

Given the importance of the technical analysis feature of computerized spectrum management, it is obvious that the various technical and operational characteristics required by the technical analysis operation are crucial to the correct operation of the system. There are several key data elements upon which technical analysis is based. Accurate information on these key elements is indispensable. If the system is given incorrect or inaccurate data, it will produce inaccurate or invalid results. This is especially true of computerized frequency management operations. The following list comprises the basic and essential data elements required for an automated frequency management system to effectively manipulate data and produce useable results for spectrum management purposes:

Criteria for Transmitting Stations:
- Exact coordinates of the transmitting station to a tolerance of +/- 3 meters
- Transmitter power in dBw
- Proposed transmit frequency (if applicable)
- Effective height of transmitting antenna
- Gain of the antenna in dB
- Transmission line loss in dB (including connectors)
- Filters or devices in the transmission line with associated losses/gain in dB
- Antenna polarization
- Azimuth main lobe of the antenna

Criteria for Receiving Stations:
- Coordinates of receiving station to a tolerance of +/- 3 meters
- Antenna Gain and Line Loss in dB
- Filters or devices in the reception line with associated losses/gain in dB
- Antenna polarization
- Azimuth main lobe of the antenna
- Ambient Noise environment (as applicable)

When POSTEL acquired the AFMS, the first priority was to operationalize the system by entering data into the database. This involved taking all of the existing technical and operational parameters of the radio stations in Indonesia from paper and license application records and converting them into a specific format suitable for the computer database. This is always a critical juncture in changing from a manual to automated system of any kind, regardless of the ultimate application of the information.

When the data conversion process began in POSTEL, it became immediately apparent that much of the information resident in paper records was questionable, completely wrong or missing entirely. Under normal circumstances in frequency management practices, this problem can be lessened somewhat by substituting established and well known "default values" for certain technical elements required for technical analysis. These default values are traditionally conservative estimates designed to provide the calculation process with worst case scenarios that lead to workable results erring on the side of caution. However, this is an inefficient measure in that not all frequency possibilities are subsequently considered for assignment by the computer. Consequently, this measure should be used sparingly. Also, there are certain technical elements which simply cannot be defaulted or substituted for technical analysis computing purposes. Table 1 lists the elements essential for basic technical analysis in a computer based frequency management system together with an indication as to whether default values can be applied, as appropriate.

Table 1: Technical Elements Required for Computer Analysis*

Essential Data Element	<960 MHz	Default	No Default	>960 MHz	Default	No Default
Accurate Station Coordinates	X		X	X		X
Base Station Power	X	X		X	X	
Gain of Antenna	X	X		X		X
Effective Antenna Height	X		X	X		X
Line Losses	X		X	X		X
Filters/Duplexers	X		X	X		X
Antenna Polarization	X	X		X		X
Radiation Pattern	X			X		
Azimuth main lobe	X	X		X		X
Bandwidth	X	X		X	X	
Antenna Azimuth	X	X		X		X

*The default values that can be applied are derived from national standards, policies and system design criteria but should in all cases be consistent with good spectrum management principles and practices.

STUDY CRITERIA

The approach adopted for this study had four main elements.

a) interview and interact with spectrum management working level and managerial levels within POSTEL with regard to the perceived and actual problems regarding the database;

b) determine the work practices involved with the reception of a typical license application including but not limited to it's processing trail;

c) on the basis of information received in a) and b), to complete an informal questionnaire comprised of a series of questions designed to provide an overall perspective of activities associated with basic spectrum management practices in POSTEL impacting on the database;

d) obtain random samples of database entries from the most congested parts of the radio frequency spectrum in Indonesia for analysis purposes.

In completing these four activities, a relatively complete overview of the radio station licensing activity was acquired as it relates to the database together with highlighting shortcomings of the database.

ANALYSIS

In the early 1990's, when POSTEL acquired the AFMS, the first task and priority was to go through each license application folder and extract the information and data elements necessary for the technical analysis component of the AFMS to function properly. At the same time, other data elements equally important to efficient spectrum management, but not of a technical nature, were also to be extracted for input to the computer system. These were considered "operational" and/or "administrative" data. Together, the technical, operational and administrative data were to comprise the fundamental core of information necessary for the AFMS to function effectively.

An examination of the database samples indicates that this very important task was ***not effectively achieved***. The less than optimal beginning has had a long-term negative impact on the AFMS. In the lower part of the radio frequency spectrum below 960 MHz. a significant percentage of the basic and essential data elements are unreliable, ambiguous or completely missing. Above 960 MHz the problem is still evident but not generally as pervasive.

Statistical Sampling

Sample extracts of the database were obtained for the following bands of spectrum:

150.5-156.7625 MHz
455-460 MHz
7850-7900 MHz
10 -10.45 GHz
14.3-14.4 GHz

An example of the error rate for the sample bands, defined by essential elements, is provided below:

Band 150.5-156.7625 MHz.

Number of Files Examined	Total data elements	Number of faulty/missing	Percentage of Error
14	154	82	53%

Band 455-460 MHz

Number of Files Examined	Total data elements	Number of faulty/missing	Percentage of Error
12	132	59	45%

Band 7850-7900 MHz

Number of Files Examined	Total data elements	Number of faulty/missing	Percentage of Error
14	154	38	25%

Band 10-10.45 GHz

Number of Files Examined	Total data elements	Number of faulty/missing	Percentage of Error
13	143	50	35%

Band 14.3-14.4 GHz

Number of Files Examined	Total data elements	Number of faulty/missing	Percentage of Error
13	143	85	59%

In summary, there were approximately 314 faulty or missing data elements in the 726 fields examined, constituting a 43% rate of error.

Factors Impacting the Quality of the Database

It appears that the database has been a problem for many years. There have been several factors which appear to have caused the problem.

Factor 1: The lack of integrity of the original data as transferred from paper records appears to have been a case of poor data being transferred from one medium (paper files) to another medium (the computer database). Consequently, whatever shortcomings existed then continue to exist now.

Factor 2: The license application process wherein applicants arrive in POSTEL with inadequate technical and operational information appears to be a focal point for the potential introduction of faulty information. It is at this point where the interface between the applicant and POSTEL personnel first occurs. It is also at this point that a check for completeness and verification of data on the application form must take place. There is some question as to whether the technical and operational thoroughness of this application check was carried out adequately in the past or is being applied now. If the application is lacking in accurate or complete data at this point, it will continue to be lacking during the license processing steps and ultimately into the database. Figure 1, Appendix 1 illustrates the current workflow pattern.

Factor 3: There appears to be no formal operational or technical scrutiny process applied to the application. It is not known if an application contains true and correct technical or operational data, especially for the essential elements described in Table 1. This could well be the result of lack of or inadequate training or knowledge as to what is required.

Factor 4: The importance of valid data and the maintenance of a viable and complete database for proper functioning of the AFMS, while acknowledged by the personnel of POSTEL, have not resulted in the corresponding effort to correct the problem as would normally be expected. This may be due to lack of available personnel or again, simply an inadequate knowledge base required for undertaking the task.

Factor 5: Applications which are completed and submitted by large entities employing the services of persons knowledgeable in telecommunications appear to possess a significantly lower incidence of technical and operational data element errors. It would appear that the quality of the data may depend more on the organization submitting data, than on reviews by the staff of POSTEL.

There is no doubt that the combination of events which have taken place since POSTEL first acquired automated spectrum management capabilities have combined to result in and perpetuate a significantly flawed database. Persons within the organization who would normally be required to access the AFMS using certain technical analysis modules for everyday activities have, in many cases, abandoned the effort and reverted to manual calculations for frequency assignments. This is inefficient and prone to error, not to mention a waste of expended financial resources.

Moreover, if POSTEL chooses to upgrade it's computing facilities at some time in the future without first taking the time and investing the effort to correct the current database, any subsequent migration of existing data to a new system will merely move the problem from one system to another. The inefficiencies and problems will remain and continue to grow in any new system that is being contemplated.

RECOMENDATIONS FOR CORRECTIVE ACTION

Despite its current problems the AFMS database can be corrected and brought up to a useable level of operation through a coordinated series of measures. The following set of Recommendations forms the substance of a Project to achieve that goal. The suggested recommendations will require an unqualified commitment by the senior management of POSTEL to implement, authorize and carry out to completion the necessary measures.

The Plan proposes a modest temporary allocation of personnel dedicated to the Project until successfully completed. The fundamental aspects of the Plan entail:

i) *a thorough file review by qualified personnel;*

ii) *a coincident refresher course to the appropriate personnel as to what is required at the point of application receipt;*

iii) *establishment of a formal review process of existing old and new data element input to the database;*

iv) *A structured and coordinated program of information retrieval by POSTEL or other temporary personnel. This includes targeted on-site inspections as required;*

v) *A periodic audit and reporting process to the Deputy Director General of on-going Project progress.*

All of the current activities and recommended functions in this report are performed by positions and persons in a direct reporting relationship to the Deputy Director General for Spectrum Management or his Section Heads within POSTEL. Therefore, the span of control and required action are all within the same operational unit and require no exterior coordination or participation by other Government agencies or Department branches.

Recommendation 1- Establishment of a Project Team

There is currently no coordinated, formalized or established program responsibility for updating and maintaining the integrity of the POSTEL database. **It is therefore recommended** that a Project Team of from 4 to 5 persons be created immediately to begin the process of reviewing existing licensing data and overseeing new applications arriving at POSTEL. The Team should consist of a Team Leader, a Supervisor and at least two other members. As a minimum, the Team leader and Supervisor must possess a good working knowledge of the AFMS and of effective spectrum management techniques and the technical analysis data elements necessary for efficient operation of the database and the various technical analysis modules. Figure 2, Appendix 1 illustrates the hierarchy of the proposed Project Team.

This team must remain intact for the duration of the database Project but can be disbanded once the Project has been completed and the database is considered accurate. At that time, a permanent database audit mechanism can be put in place.

(An acceptable alternative could be the temporary employment of graduate university students enrolled in electronics-related studies to work under supervision in the retrieval of required information.)

<u>*Recommendation 2*</u> *– Work Flow Integration by the Project Team*

The Project envisages a simultaneous 2-phased approach. One objective is to disrupt the on-going POSTEL licensing system as little as possible. The second is to begin and complete a review of each licensing record currently in the POSTEL database.

It is recommended that in order to satisfy *Phase one*, that all incoming applications be vetted by a knowledgeable Team member to verify and ensure that all of the administrative, technical and operational database elements are included, correct and viable. With the establishment of an efficient coordinated workflow process, this can be accomplished with a minimal disruption to the incoming applications. If this Phase is not implemented, erroneous information will continue to enter the database and the current problem will continue.

POSTEL currently has a new automated Geographic Information System (GIS) enabling the reference determination of station locations. While the accuracy of this new program has not yet been established, this feature could greatly facilitate the verification of new license applications. <u>Figure 3, Appendix 1</u> illustrates the point of introduction of the Project Team's participation.

Phase two of this recommendation involves a methodical inspection of each licensing record of the current POSTEL database. This inspection process would result in those records which are faulty or incomplete being tagged and scheduled for further investigation by the Team members. It is recognized that this is a lengthy process but experience has shown that there is no viable alternative. The Team leader and his/her Supervisor should be given prime responsibility for this task. <u>Figure 4 Appendix 1</u> illustrates the parallel operation and effect of the Project Team

In extreme cases, where acquiring basic technical information is deemed to be impossible or impractical by the Team leader, technically calculated *worst case scenario defaults should be substituted, where they are permissible.* This will allow the AFMS technical analysis modules to operate, albeit while producing compromised results.

<u>*Recommendation 3*</u> *– Liaison and Scope of Authority of the Project Team*

The approach proposed in Recommendation #2 will result in a significant number of files and records requiring further action by the Team. These files should be identified for immediate corrective action.

It is recommended that a process be put in place which allows the Data and Liaison Team members to take whatever action is deemed necessary to contact the licensees to obtain missing information. The reporting relationship must be bi-directional which will allow difficult cases to be reported to and resolved at the supervisory and Team Leader level.

<u>*Recommendation 4*</u> *– Support by Field Personnel*

This project will require the assistance and intervention of Inspection personnel in the field. However, the current procedure for acquiring the assistance of field personnel is cumbersome, exceedingly slow and non-responsive. In a long-term project such as this, formalized bureaucratic processes unnecessarily hinder effective management.

It is therefore recommended that to speed up the process and for the duration of this project, the Team Leader and Supervisor be empowered to deal directly with management levels in the field to initiate on site inspection requests for essential database elements. The results of these inspections should be relayed directly to the Project Team for evaluation. Administrative formalities, which result in a slowdown in the acquisition and reporting of information, should temporarily be eliminated.

Recommendation 5 – Capture of Information

Many of the existing licensing records which were acquired at the inception of the AFMS contain information which is incomplete or inaccurate. This information has not been corrected in the intervening 12 years. One argument is that the human and financial resources were not available for this long-term task. However, an ideal mechanism exists to update this old inaccurate information.

The annual license renewal program currently employed by POSTEL advises license holders of renewal fee requirements at two months before the expiration date of the license. At that time, the license holder is required to make payment to the POSTEL account using bank facilities.

It is recommended that for existing files with inaccuracies or missing information, licensee be advised in their renewal fee notice that they must appear at POSTEL offices to supply additional information regarding their radio facilities. This would be a one-time occurrence and will assist POSTEL in upgrading essential data in the files. Failing to comply would result in an un-renewed license. Since licenses generally expire on the 12 month anniversary of their issuance, the workload involved in this recommendation will be evenly distributed over a 12 month period.

Recommendation 6 – Logistics Control

Currently, database manipulation is centralized and controlled within POSTEL. This is a prudent and necessary precaution. However, the Project Team will need to access the database for frequent updates. This will require a close liaison between the Project Team and the database maintenance personnel.

It is recommended that a small ad-hoc standing committee be formed between the Project Team, the Head of the Data Entry Unit, the Database System Administrator and the Deputy Director General in order to ensure that progress and information flows are expedited for the duration of the project.

Recommendation 7 – Systems Knowledge and Training

During our discussions, we heard persistent concerns about the lack of training in efficient spectrum management and how the AFMS can contribute in this regard. Apparently, there have been technical training courses given POSTEL personnel in the past, but personnel changes have negated the usefulness of the training. Those who have received this training have in many cases moved to other positions or have been unable to apply the training due to the poor quality of the database. The result is that the training

that was given was not passed on to peers or is not being applied. This is a circular problem which shows no signs of improvement.

It is recommended that a small group of people who will be intimately involved with manipulation and daily use of the database information be given a short but intensive training course (of from 3 to 5 days) on the various important aspects of certain data elements and how they contribute to efficient spectrum management. As a minimum, the proposed Project team should be candidates for this training. The training should also be given to at least three frequency assignment personnel. The total training class size, for purposes of efficient transfer of information, should not exceed 10 persons. Persons given this training would be expected to, in turn, train their colleagues and provide on-the-job training. The training should be conducted at premises where attendee's cannot be interrupted by daily job requirements.

Recommendation 8 – Information Updating and User Compliance

As has been stated throughout this report, the spectrum management database is the core and foundation of any viable automated spectrum management system. Consequently, developing a high degree of accuracy and reliability within the database is of fundamental importance. Once this is achieved, POSTEL will have taken a major step towards a modern and viable automated spectrum management system. However, there would be little point to correcting the database if the corresponding steps to maintain its integrity in the future were not also undertaken. POSTEL currently has the means and equipment for achieving this objective.

It is recommended that once the database is deemed to be correctly updated and reliable, a program of compliance or spectrum enforcement be implemented within POSTEL to ensure that the database remains accurate and up to date. A basic means to achieve this goal is the systemized use of automated and manual monitoring information. This information can be fed into the AFMS database as a means of ensuring that user compliance is being adhered to and enforced. There is little point in spectrum management of licensing users with certain station operating parameters if there is no means to ensure compliance with POSTEL's licensing conditions.

Recommendation 9 – Data Sources and Standards

Experience has shown that a critical source of accurate information is at the first interface between the license applicant and the regulator, i.e. at the beginning of the application process. There is a shared responsibility for proper use of the spectrum between those who use the radio frequency spectrum and those responsible for its management and regulation. In other words, the assistance and cooperation of equipment manufacturers and equipment vendors plays an important role in maintaining a clean and efficient spectrum resource. This mutually advantageous relationship can be easily established and maintained through a modest expenditure of time and human resources. The cooperation of active manufacturers in Indonesia, such as Marconi, Tate, Kenwood, Motorola, Rohde & Schwartz and other suppliers of equipment *and their vendors,* can make an invaluable

contribution towards the submission of more accurate and complete information to POSTEL for licensing purposes.

It is recommended that POSTEL initiate ad-hoc arrangements with the equipment manufacturers and vendors active within Indonesia. The goal would be to conduct information seminars regarding the correct and comprehensive completion of POSTEL license applications and the information required for efficient and effective spectrum management.

SUMMARY

The above Recommendations constitute *a time-tested and relatively economic method of* overcoming the problems with the database underlying POSTEL's Automated Frequency Management System. The AFMS, like any other computerized program or system, can not work effectively without this basic foundation. Currently, the AFMS in Indonesia is operating at less than 25% effectiveness and efficiency. This is detrimental to the Ministry and its clientele, the telecommunications community of Indonesia. It also impacts adversely on Indonesia's international role and commitments to the ITU. Other Administrations have been faced, in varying degrees, with this problem and virtually all have corrected it by means of a methodical and planned approach such as is proposed here.

These proposals and recommendations describe a project which will require a dedicated but temporary expenditure of human resources. However, if implemented and properly completed, the expenditure will result in tangible efficiencies and savings which more than compensate for any short term costs.
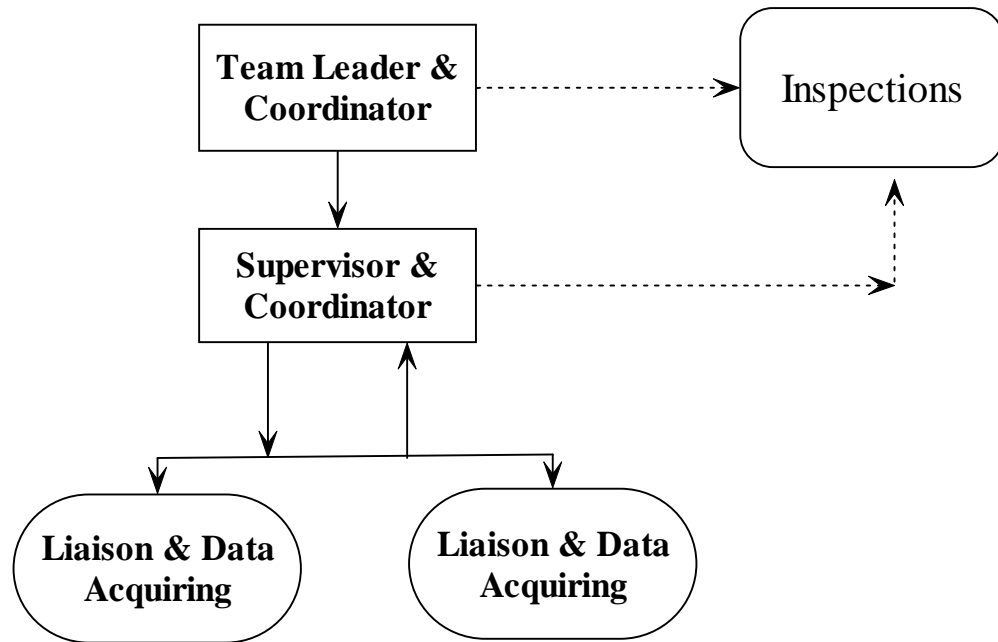
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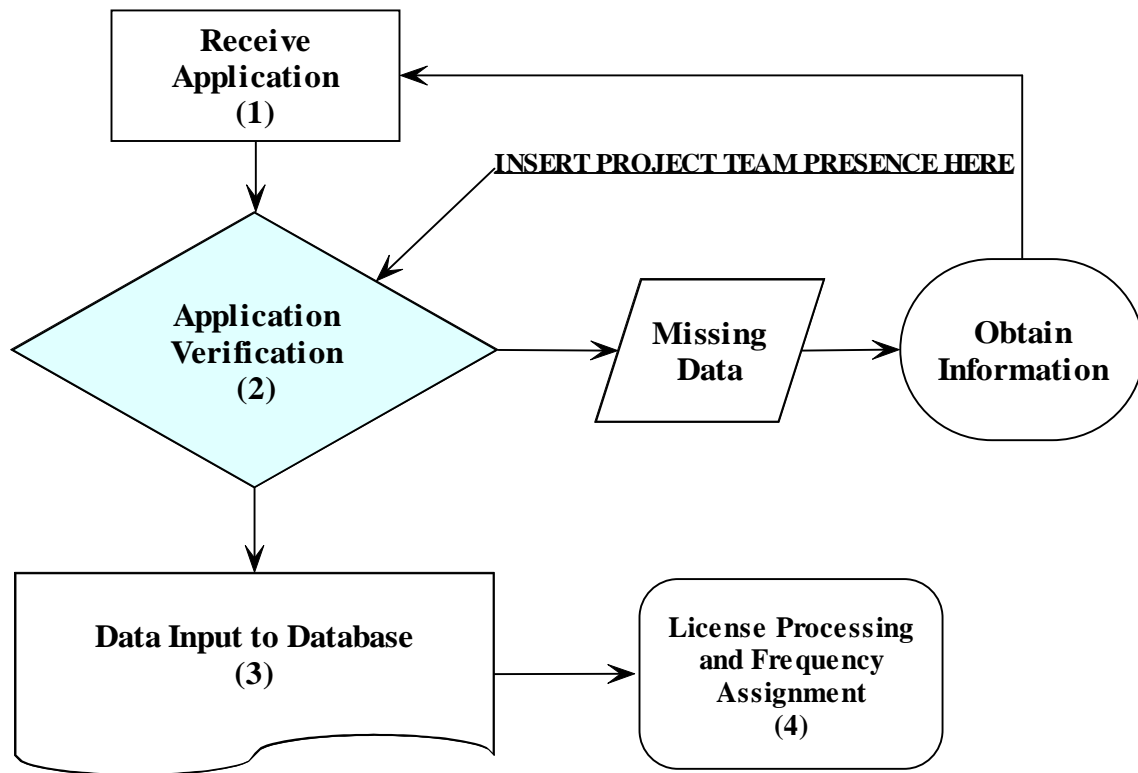
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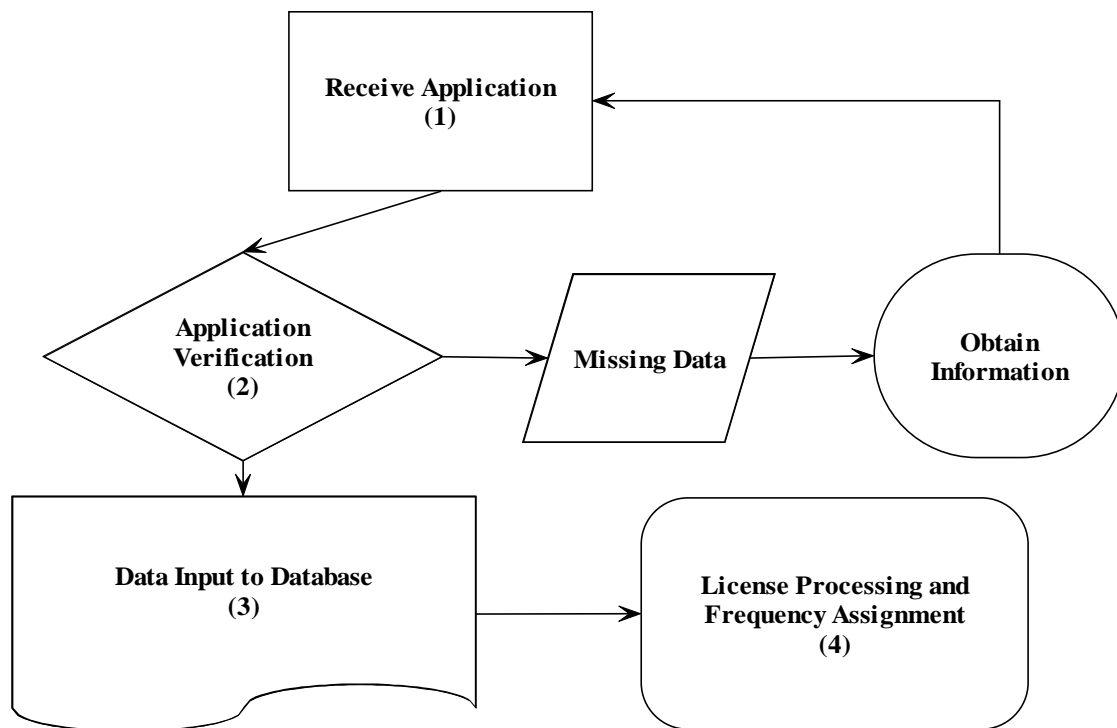
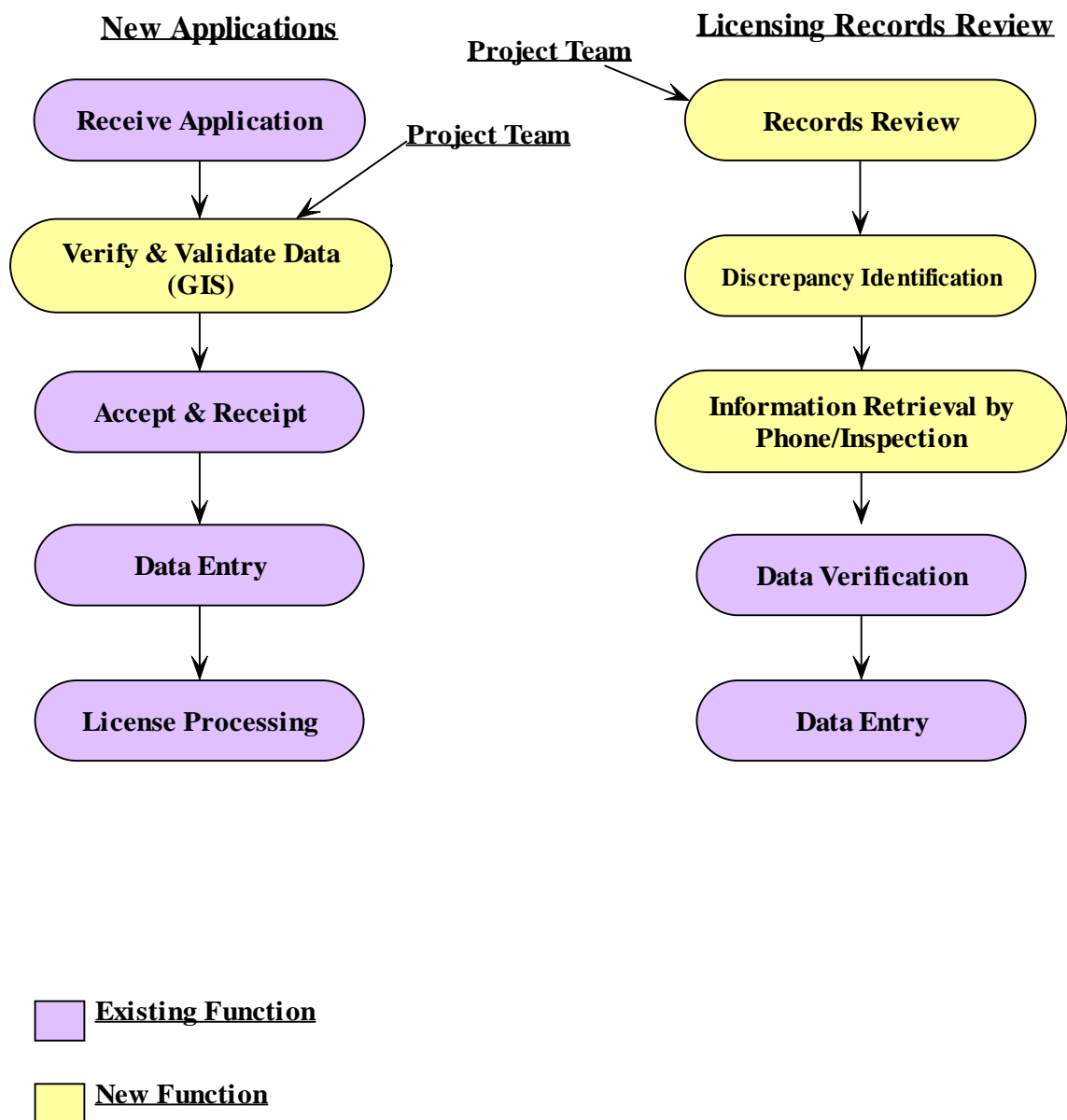**Figure 1**

Project Team Reporting & Liaison Component

Figure 2

Proposed Revised License Application Flowchart

Figure 3

Work Processes

New Applications

Receive Application

↓

Verify & Validate Data (GIS)

↓

Accept & Receipt

↓

Data Entry

↓

License Processing

Licensing Records Review

Records Review

↓

Discrepancy Identification

↓

Information Retrieval by Phone/Inspection

↓

Data Verification

↓

Data Entry

Project Team →

Project Team →

Existing Function

New Function

Figure 4